Earlier Parturition in Older Copper Rockfish (*Sebastes caurinus)* in the San Juan Islands, Washington

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Abstract

The relationship between maternal size or age and date of parturition for copper rockfish, *Sebastes caurinus*, was investigated by estimating parturition dates of females using embryo developmental stage data. Mean parturition date was earlier for older females than younger females. Older and younger females may have different recruitment success in a given year, although this effect would be reduced by the overlap in the parturition periods for older and younger fish.

Introduction

Population abundance has declined for some species in the genus *Sebastes* due to commercial and/or recreational fishing mortality (Parker et al. 2000). Removal of older and larger fish has also caused truncation of age and length distributions for some species in the genus (Parker et al. 2000). The copper rockfish, *Sebastes caurinus*, population in Puget Sound, Washington, is an example of a rockfish population with decreased abundance and a truncated length distribution (NMFS 2001).

No-take reserves, commonly called Marine Protected Areas (MPAs), may be a tool for increasing the number of older and larger fish in a population. MPAs have been shown to contain larger copper rockfish than similar fished sites (Palsson 1997; Eisenhardt 2001).

Differences in reproduction at maternal length become relevant issues due to the different length structures of fished and unfished populations. One possible reproductive difference between large and small females is date of parturition. Older or larger females parturate earlier in the season than younger or smaller females in *S. flavidus* (Eldridge et al. 1991), *S. crameri* (Nichol and Pikitch 1994), and *S. melanops* (Berkeley and Markle 1999). In *S. melanops*, larvae from some periods in the parturition season had higher survival rates than larvae from other periods (Berkeley and Markle 1999). Other fish species share this trend of surviving larvae being spawned disproportionately during certain periods of the spawning season (Methot 1983; Moksness and Fossum 1992; Wright and Bailey 1996). Populations with different age and length structures could therefore have different recruitment success.

The objective of this study is to determine if larger female copper rockfish parturate earlier than smaller female copper rockfish.

Methods

Samples were collected in the San Juan Islands area by hook and line, or using SCUBA and spear. Samples were collected from February 2 through April 10, 2002. Weighted jigs with rubber worms were used for hook and line sampling. Fish were placed in an ice and saltwater slurry, and brought to the laboratory for processing. Total length and fork length were taken to the nearest mm. Otoliths from each sample were placed in 95% ethanol.

Small samples of fresh embryos were observed for embryo stage identification using a stereomicroscope and then preserved in 3% formalin in optical saline solution for future embryo stage verification. This was important, as the formalin in optical saline solution preserved the embryos with less distortion than formalin in seawater. The technique was adapted from Stahl-Johnson (1984), who used formalin in medical grade saline.

Embryos of gestating females were staged according to developmental stages created for copper rockfish by Stahl-Johnson (1984), and modified by Dygert (1986). Dygert (1986) estimated the duration of each embryo developmental stage. This information was used to estimate number of days to parturition for each fish (Table 1), and was added to the collection date to estimate date of parturition. A Mann-Whitney non-parametric test (Zar 1999) was used to compare mean parturition date of older and younger fish.

Table 1. Estimated days to parturition by embryo stage (adapted from Dygert 1986) and using *S. schlegeli* temperature correction estimate.

Embryo stage	Days until parturition	Days until parturition using *S. schlegeli* temperature correction estimate
1	43	47
2	42	46
3	40	44
5	37	41
6	36	40
7	33	36
8	29.5	32.5
9	23.5	26
10	21.5	24
10.5	17	19
11	13	14
11.5	9	10
12	6	7
12.5	2	2
13	0	0

During the gestation period of the fish in this study, the water temperature of the collection area was colder than water temperatures during the previous embryo stage duration studies (See results). The effect of temperature on the rate of copper rockfish embryo development is not known. To estimate the effect of temperature, the percent increase in embryo gestation time for the same magnitude temperature decrease in *S. schlegeli* was assumed. The total gestation time estimated by Dygert (1986) used in this study was 43 days. Although Dygert's (1986) gestation estimate was derived from a temperature range of 8.3 – 11.5 ˚C, it is close to the 41 – 43 day gestation estimate from Stahl-Johnson's (1984) data alone, which was obtained from fish in a lower and more narrow temperature range of 8.3 – 9.1 ˚C, which was about 0.9 ˚C higher than the 7.8 ˚C mean ambient temperature observed in this study. A 0.9 ˚C temperature increase from ambient gestation temperature for *S. schlegeli* would cause a 10.2% increase in gestation time (Yamada and Kusakari 1991). Gestation estimates were increased by 10.2% to estimate the possible temperature effects on the results (Table 1).

The left sagittal otolith of each fish was sent to the Washington Department of Fish and Wildlife (WDFW) for age determination using the break and burn method.

Results

When grouped by length, a difference in spawning date between larger and smaller fish was not apparent (Figure 1). However, when grouped by age, older females had an earlier mean parturition date than younger females (Figure 2). The difference in mean spawn date between the two age groups was significant (Mann-Whitney, $p < 0.05$).

During this study, temperatures at collection depth ranged from 7.3 to 8.7 ˚C during the gestation period (Lucie Weis, University of Washington School of Fisheries and Aquatic Sciences, unpublished data). Spawn date by age groups estimated using a correction derived from *S. schlegeli* data showed a similar trend of an earlier mean parturition date for older fish (Figure 3), and results were significant (Mann-Whitney, $p < 0.05$).

Discussion

Because older fish in this study had an earlier mean date of parturition than younger fish, an age truncated population may have a different temporal distribution of larvae during the parturition period than a virgin population, which could lead to differences in successful juvenile recruitment. If a population has older/larger fish removed, and the younger/smaller fish do not spawn earlier for density-dependent reasons, then an age/length truncated population will have a later and shortened parturition season. If environmental conditions suitable for larval survival occur randomly during the parturition season, higher variation in recruitment success may result. If environmental conditions favoring larval survival tend to occur more often in the early part of the parturition season, then a population with a truncated length and age distribution could have less successful recruitment than a virgin population.

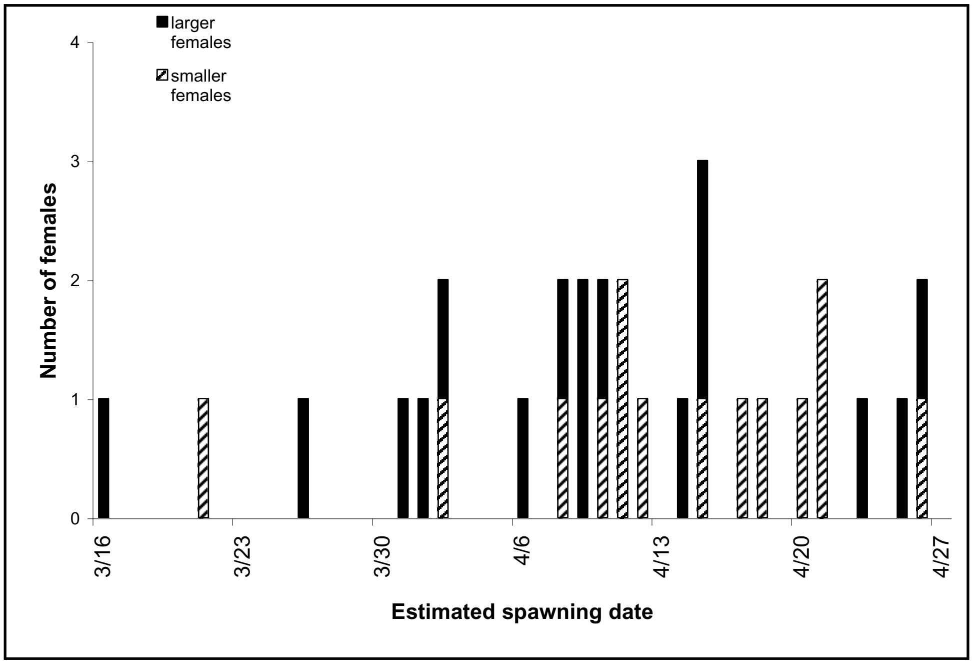

Figure 1. Estimated spawning dates of smaller (224 – 280 mm TL) and larger (281 – 428 mm TL) females.

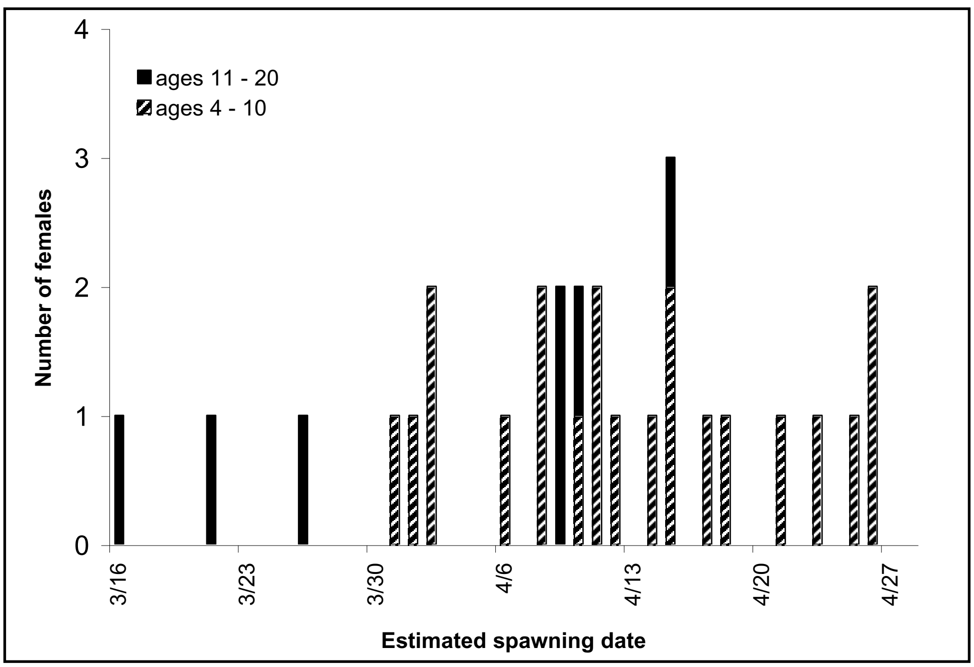

Figure 2. Estimated spawning dates of younger (4-10 years) and older (11 - 20 years) females.

Parturition dates for older and younger fish did overlap, which would decrease temporal differences in larval production between populations with different age distributions. Also, despite the truncated size range and presumably truncated age range of fish in this study, the length of the parturition period was generally the same as the parturition period reported for the same geographical area by Moulton (1977), although very little is known about interannual variation in the timing or length of the parturition period. It should be noted that fish sampled for this study did not include larger and presumably older fish compared with historical size ranges (Moulton 1977; DeLacy et al. 1964).

Additional years of parturition date estimates combined with surviving juvenile parturition date estimates would help determine the significance of the earlier parturition date for older fish.

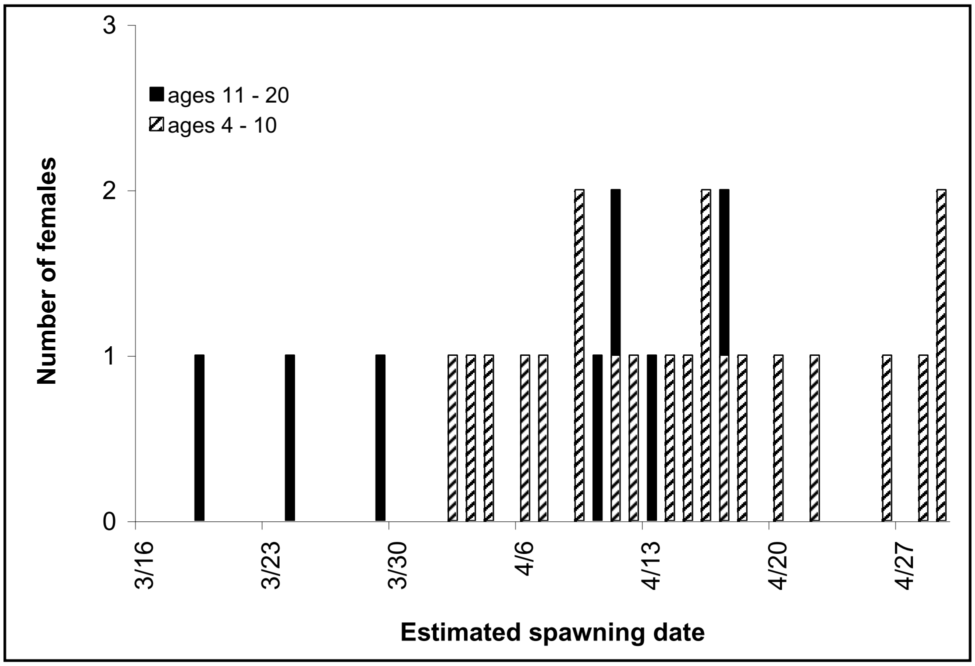

Figure 3. Estimated spawning date for age groups with *S. schlegeli* temperature correction estimate.

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